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ECOLOGICAL STATE OF THE XUN RIVER NEAR THE VILLAGE OF SHARAN IN THE SHARANSKY DISTRICT OF THE REPUBLIC OF BASHKORTOSTAN

Research article

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Abstract

The article presents the results of a comprehensive assessment of the ecological state of the Xun River, a key water body in the Sharansky district of the Republic of Bashkortostan. The relevance of the study is due to the increased anthropogenic pressure on aquatic ecosystems in conditions of urbanization and insufficient water supply in the region. The paper presents the results of assessing the quality of a watercourse using organoleptic, hydrochemical and bioindication methods. The material was water and biota samples taken in August 2023 by the method of route-expedition observations. The organoleptic parameters of the water corresponded to the standards: the color was 19 °, the odor was 1 point (earthy), the transparency was 31 cm, and the temperature was 15 °C. All hydrochemical parameters were within the limits of MPC according to GN 2.1.5.1315-03. The faunal diversity is confirmed by the presence of *Thymallus thymallus*, a strict indicator of the purity of a reservoir listed in the Red Book of the Republic of Bashkortostan. The flora of the catchment area is represented by 40 species from 11 families, with forest communities dominating (55% of the territory). The data obtained indicate the favorable ecological state of the Xun River and confirm the effectiveness of an integrated approach to monitoring water bodies.

Keywords: Xun River, water quality, organoleptic parameters, hydrochemical analysis, bioindication, European grayling, Sharansky district, Republic of Bashkortostan.

ЭКОЛОГИЧЕСКОЕ СОСТОЯНИЕ РЕКИ СЮНЬ В РАЙОНЕ СЕЛА ШАРАН ШАРАНСКОГО РАЙОНА РЕСПУБЛИКИ БАШКОРТОСТАН

Научная статья

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Аннотация

В статье представлены результаты комплексной оценки экологического состояния реки Сюнь — ключевого водного объекта Шаранского района Республики Башкортостан. Актуальность исследования обусловлена усилением антропогенной нагрузки на водные экосистемы в условиях урбанизации и недостаточной обводнённости региона. В работе приведены результаты оценки качества водотока с применением органолептических, гидрохимических и биоиндикационных методов. Материалом послужили пробы воды и биоты, отобранные в августе 2023 г. методом маршрутно-экспедиционных наблюдений. Органолептические показатели воды соответствовали нормативам: цветность составила 19°, запах — 1 балл (землистый), прозрачность — 31 см, температура — 15 °C. Все гидрохимические параметры укладывались в пределы ПДК согласно ГН 2.1.5.1315-03. Фаунистическое разнообразие подтверждено наличием хариуса европейского (*Thymallus thymallus*) — строгого индикатора чистоты водоёма, занесённого в Красную книгу Республики Башкортостан. Флора водосборного бассейна представлена 40 видами из 11 семейств при доминировании лесных сообществ (55% территории). Полученные данные свидетельствуют о благоприятном экологическом состоянии реки Сюнь и подтверждают эффективность комплексного подхода к мониторингу водных объектов.

Ключевые слова: река Сюнь, качество воды, органолептические показатели, гидрохимический анализ, биоиндикация, хариус европейский, Шаранский район, Республика Башкортостан.

Introduction

At the current stage of society's development, it is important to monitor the quality of water resources in a timely manner. In the Russian Federation, the quality of water in many water bodies, especially large ones, does not meet the regulatory requirements. Among the main rivers of Russia, the Volga and Yenisei are characterized by the greatest environmental problems. They are rated as "polluted". Their major tributaries — the Oka, Kama, Irtysh, and Miass — are assessed as "heavily polluted" [1], [2].

The ecological condition of surface waters in the Republic of Bashkortostan is considered satisfactory and has been improving in recent years [3]. There are more than about 13 thousand rivers. The largest river of the Republic of Bashkortostan



is the Belaya River, the largest tributary of the Kama River. The Belaya River originates in Uchalinsky district at an altitude of 745 m at the foot of the Avalyak ridge, and then receives many tributaries. The Xun River (Seng) is a left tributary of the Belaya River, originating south of the village of Novo-Sabanaevo, Sharansky district, and then flowing through Bakalinsky and Ilishevsky districts. The length of the Xun River is 209 km, the drop is 207 m, the average height is 177 m. The Xun River is characterized by a high degree of overregulation of river flow [4]. The main waterways of the Sharansky district are the Xun and Ik rivers, as well as the Sharanka and Shalytk rivers and more than 30 tributaries, most of which are tributaries of the first and second orders of the Xun River. These watercourses have historically determined the features of the settlement of the population, economic activity and the formation of a local way of life in the region. In Bashkortostan, studies of the ecological state, flora and ichthyofauna of the Xun River in the Bakalinsky district were conducted [5], [6], [7]. In Sharan district, the hydrochemical parameters of the Xun River were studied in 2017 [8], but the flora was not studied.

The purpose of the study is to assess the ecological state of the Xun River as one of the main watercourses of the Sharan region. Research objectives:

- 1) to evaluate the organoleptic and hydrochemical parameters of the Xun River in the Sharan village area;
- 2) to study the flora and fauna of the Xun River drainage basin in the Sharan village area.

Research methods and principles

The flora study was conducted in August 2023. The collection of primary material was carried out by the route-expedition method with the fixation of the spatial distribution of the objects of study. The flora was studied along the Xun River in the vicinity of Sharan village within a radius of 3 km, the total catchment area was 10 km². The ichthyofauna was studied in August 2023 using traps installed on the Xun River at a distance of 1 km above and 1 km below the village of Sharan. Two stationary nets were used for trapping: one 25 m long with a mesh size of 20 mm, the other 35 m long with a mesh size of 30 mm. During the month, 4 networks were installed. The species belonging to representatives of flora and fauna was determined using modern plant and animal determinants [9], [10], as well as the digital resource Plantarium (plantarium.ru) [11] to verify taxonomic affiliation.

In 2023, samples were taken 4 times in spring and autumn (each sampling included 5 samples) using a sampler in sterile glass containers with a volume of 1 dm³. Water sampling from the Xun River was carried out in accordance with GOST R 59024-2020 "Water. General requirements for sampling" [12]. The water survey was conducted in the Xun River at 3 points:

- 1) 100 m from the village of Sharan;
- 2) 1 km upstream;
- 3) 1 km downstream.

The samples were delivered to the laboratory of environmental monitoring of physico-chemical pollution of the Birsky branch of the Ufa University of Science and Technology (UUNiT), where hydrochemical parameters were determined using standard analytical methods of water quality control in reservoirs.

The organoleptic parameters were evaluated in the spring and autumn of 2023 in the field in accordance with the requirements of GOST 24902-81 "Drinking water. General requirements for field analysis methods" [13]. The water temperature was measured twice a week directly in the riverbed using a calibrated thermometer, which was lowered to a depth of 20 cm for 5 minutes. Turbidity was determined by the "standard text" method — by the minimum height of a column of water in a transparent cylinder, which preserves the ability to distinguish typographic text on a white background. The method complies with GOST R 57164-2016 "Drinking water. Turbidity determination" and is applicable for rapid assessment of water quality in the field [14].

Main results

The results of studying the organoleptic parameters of the Xun River water in the Sharan village area, as well as above and below the main sampling point, are shown in Table 1.

Table 1 - Results of organoleptic parameters of the Xun River in the area of Sharan village

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Indicators	Unit of measurement	Indicators Xun River near Sharan village	Upstream (1 km from Sharan village)	Indicators downstream (1 km from Sharan village)	MPC standards
The color of the water	degree	19.25 ±0.1	18.31±0.1	19.33±0.1	Less than 35
Smell	points	1	1	1	Less than 2
Temperature	degree	15.30±0.2	15.21±0.2	15.09±0.1	Absent
Taste	Celsius points	2	2	2	Absent
Transparency	cm	31.12±0.14	30.11±0.21	31.18±0.17	More than 25

According to the results of the organoleptic analysis, the water of the Xun River is characterized by the following indicators.

The taste, both in spring and autumn, was assessed as weakly expressed both at the sampling point near the village of Sharan, and upstream and downstream (2 points on a five-point scale), distinguishable by careful perception, but not causing unpleasant sensations.

The odor in the analyses and at all sampling points was weakly pronounced (1 point) and had a characteristic earthy hue, which may indicate the presence of organic compounds of natural origin or the activity of microorganisms in the sediments. A comparison of the results of the study of organoleptic indicators conducted by us shows that the taste and smell of the river have not changed since 2017 in comparison with the indicators obtained by other authors [8].

The color of the water at all points was 19°, which corresponds to a pale yellow color when viewed visually from above. This color is due to the presence of humic substances entering the watercourse with surface runoff from swampy and wooded areas of the drainage basin, which is also consistent with the data of other authors [8]. The water temperature was 15 °C in autumn and 12 °C in spring, which corresponds to the seasonal climatic conditions of the region during the study period. All organoleptic parameters of the water in the Xun River comply with the requirements of GOST 24902-81 [13] and do not exceed the maximum permissible standards for drinking and cultural reservoirs.

The results of the hydrochemical analysis presented in Table 2 indicate the compliance of all studied parameters with the standards of maximum permissible concentrations (MPC) established by the hygienic standards GN 2.1.5.1315-03 "Maximum permissible concentrations (MPC) of chemicals in the water of water bodies for economic, drinking, cultural and domestic water use" [15] and water bodies of fishery importance [16]. The amount of heavy metals (Pb, Cd and Cu) is significantly lower than the MPC. The amount of Fe, petroleum products also does not exceed the maximum permissible concentration.

Thus, according to the totality of organoleptic and hydrochemical parameters, the water of the Xun River meets the requirements for aquatic facilities for fisheries and cultural purposes.

Table 2 - Hydrochemical parameters of the Xun River water in the area of Sharan village

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Indicators	Unit of measurement	Indicators of the Xun River near Sharan village	Upstream (1 km from Sharan village)	Indicators downstream (1 km from Sharan village)	MPC standards/
pH	Unit pH	7.43±0.02	7.31±0.04	7.44±0.03	6.5-8.5
Mineralization	mg/dm ³	253.41±1.20	259.33±1.44	260.19±2.01	1000
Rigidity	mg-eq/l	8.20±0.11	8.11±0.09	8.22±0.12	6-9
Petroleum products	mg/dm ³	0.04±0.0002	0.03±0.0001	0.04±0.0002	0.05
Pb	mg/dm ³	More than 0.002	More than 0.002	More than 0.002	0.006
Cd	mg/dm ³	More than 0.0001	More than 0.0001	More than 0.0001	0.005
Fe	mg/dm ³	0.097	0.096	0.098	0.1
Cu	mg/dm ³	0.0008	0.0009	0.0008	0.001

Thus, it can be concluded that the results of the hydrochemical analysis show that all indicators are within the MPC. Our data are consistent with previous studies of the Xun River in the Sharan region [8]. However, in the Bakalinsky district, the maximum permissible concentration for sulfate ion, iron, zinc, and manganese is observed in the Xun River [17]. No tests were performed to determine the normality of the distribution and the significance of the differences between the points (above/below the village).

For the first time, we studied the vegetation cover of the Xun River in the catchment area of Sharan village.

An analysis of the vegetation cover of the coastal zone and the floodplain of the Xun River revealed a significant participation of forest ecosystems: forest communities account for about 55% of the catchment area. The floodplain area is dominated by gallery forests dominated by *Alnus glutinosa*, which include *Salix alba* and *Betula pendula*. *Tilia cordata* is found mainly in the uplands adjacent to the floodplain, which corresponds to its ecological preferences.

The following plant species have been identified in the coastal water zone: Coastal-marsh species: *Acorus calamus*, *Carex acuta*, *Typha angustifolia*, *Alisma plantago-aquatica*, *Trollius europaeus* confined to the wet meadows of the floodplain terrace; Aquatic and semi-submerged plants: *Nuphar lutea*, *Glyceria maxima*, *Sagittaria sagittifolia*.

The taxonomic composition of the flora of the coastal zone of the Xun River in the Sharan village area is shown in Table 3. The high species diversity of the vegetation cover, including the presence of indicator species of clean reservoirs (*Nuphar*), complements the hydrobiological data and confirms the favorable ecological condition of the watercourse.

Table 3 - Taxonomic analysis of the coastal flora of the Xun River in the Sharan village area

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Family	Number of species, pcs
Coastal arboreal and shrubby flora	
<i>Ulmaceae</i>	6
<i>Betulaceae</i>	4
<i>Rosaceae</i>	4
<i>Silicaceae</i>	3
Coastal herbaceous flora	
<i>Cyperaceae</i>	4
<i>Asteraceae</i>	4
<i>Ranunculaceae</i>	5
<i>Poaceae</i>	3
Higher aquatic plants	
<i>Hydrocharitaceae</i>	4
<i>Alismataceae</i>	1
<i>Potamogetonaceae</i>	2

During the entire study period, we identified 40 plant species belonging to 11 families. The coastal flora of the Xun River includes the following species: *Dactylis glomerata* (*Poaceae*), *Poa pratensis* (*Poaceae*), *Festuca pratensis* (*Poaceae*), *Sorbus aucuparia* (*Rosaceae*), *Rumex confertus* (*Polygonaceae*), *Urtica dioica* (*Urticaceae*), *Chelidonium majus* (*Papaveraceae*), *Ranunculus acris* (*Ranunculaceae*), *Inula helénium* (*Asteraceae*), *Taraxacum officinale* (*Asteraceae*), *Trifolium repens* (*Fabaceae*), *Silaum silaus* (*Umbelliferae*), *Tussilago farfara* (*Asteraceae*), *Cichorium ichthyos* (*Asteraceae*), *Arctium tomentosum* (*Asteraceae*), *Aegopodium podagraria* (*Apiaceae*), *Salix alba* (*Salicaceae*), *Lemna minor* (*Araceae*), *Agrimonia eupatoria* (*Rosaceae*), *Veronica spicata* (*Plantaginaceae*), *Euonymus verrucosus* (*Celastraceae*), *Senecio vulgaris* (*Asteraceae*), *Equisetum fluviatile* (*Equisetaceae*), *Carex praecox* (*Cyperaceae*), *Elodea canadensis* (*Hydrocharitaceae*), *Asarum europaeum* (*Aristolochiaceae*).

The aquatic and coastal flora of the Xun River performs an important ecological function, serving as a substrate and shelter for numerous aquatic organisms. Colonies of freshwater hydroids of the genus *Hydra* (*Cnidaria: Hydrozoa*), as well as larvae of *Chironomidae* and other zoobenthos organisms, were found on the underwater parts of the leaves and stems of macrophytes.

It should be noted that adult individuals of *Diptera* and *Lampyridae* do not inhabit underwater parts of plants: *Lampyridae* are terrestrial insects with a larval stage that develops in moist soils rather than in the water column. Representatives of mammals confined to wetland ecosystems have been recorded in the coastal zone of the river: *Castor fiber*, *Lutra lutra* and *Ondatra zibethicus*.

The ichthyofauna of the Xun River is characterized by high species diversity. During ichthyological observations, the following species were identified: *Esox lucius*, *Carassius gibelio*, *Rutilus rutilus*, *Tinca tinca*, *Leuciscus leuciscus*, *Scardinius erythrophthalmus*, *Gymnocephalus cernua*, *Perca fluviatilis* and *Thymallus thymallus*.

Thymallus thymallus is a strict indicator of the quality of the aquatic environment: its presence indicates a high concentration of dissolved oxygen, a low level of organic pollution and a stable hydrological regime. The species is listed in the Red Book of the Republic of Bashkortostan [18] with a rarity category of "2" (a declining species), which emphasizes the need to preserve favorable conditions for its habitat.

Conclusion

A comprehensive assessment of the ecological state of the Xun River in the Sharan village area based on the results of organoleptic, hydrochemical and hydrobiological analyses allows us to draw the following conclusions: organoleptic parameters of water (taste, smell, color, transparency) They comply with the requirements of GOST 24902-81 [13] and do not exceed the standard values. The data is consistent with previous studies. All the hydrochemical parameters studied are within the limits of the maximum permissible concentration set by GN 2.1.5.1315-03 [15]. The data are consistent with previous studies [8]. For the first time, an analysis of the flora showed a sufficient species diversity of plants belonging to 11 families. For the first time, a study of the ichthyofauna of the Xun River in the Sharan region showed a high species diversity of aquatic organisms. The detected presence of indicator species of clean reservoirs (*Thymallus thymallus*, *Nuphar lutea*) confirms the favorable ecological condition of the watercourse, which indicates a low anthropogenic load.

**Конфликт интересов**

Не указан.

Рецензия

Сообщество рецензентов Journal of Agriculture and Environment.

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None declared.

Review

Community of Reviewers of the Journal of Agriculture and Environment.

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